it was found that the swallows, as a group, possess the lowest average body temperature. In seven species examined in this family one alone, the rough-winged swallow (*Stelgidopteryx serripennis*), showed an average greater than 107°·5 F. Humming birds also, "with their tiny bodies seem to have a considerable range in temperature, but as a whole fall low in body warmth."

The volume is an important monograph, containing much valuable data, and it is a noteworthy contribution to this field of avian physiology.

SUTHERLAND SIMPSON.

Prof. Eddington's Romanes Lecture.

Pour comprendre Einstein. Par l'Abbé Th. Moreux. Pp. 245. (Paris: G. Doin, 1922.) 7 francs.

Die Grundlagen der einstein'schen Relativitätstheorie: Eine kritische Untersuchung. Von Prof. Dr. H. Strasser. Pp. 110. (Bern: Paul Haupt, 1922.) n.p.

Philosophy and the New Physics: An Essay on the Relativity Theory and the Theory of Quanta. By Prof. Louis Rougier. Authorised translation from the author's corrected text of "La Matérialisation de l'énergie," by Prof. Morton Masius. Pp. xv+159. (London: G. Routledge and Sons, Ltd., n.d.) 6*s*. net.

Le Principe de la relativité et les théories d'Einstein. Par Prof. L.-G. du Pasquier. Pp. xvi+511. (Paris: G. Doin, 1922.) 18 francs net.

Le Principe de la relativité et la théorie d'Einstein. Par Dr. Leon Bloch. (Bibliothèque des Annales des Postes, Télégraphes et Téléphones.) Pp. iii+42. (Paris: Gauthier-Villars et Cie, 1922.) 3.50 francs.

The Romanes Lecture, 1922. *The Theory of Relativity and its Influence on Scientific Thought.* Delivered in the Sheldonian Theatre, May 24, 1922. By Prof. A. S. Eddington. Pp. 32. (Oxford: Clarendon Press, 1922.) 2*s*. net.

ANOTHER collection of books and pamphlets reminds us of the hold which the theory of relativity has on the public imagination.

The Abbé Moreux gives his book the title "Pour comprendre Einstein," though he seems to consider that the effort to understand him is so much waste of time, for in his view the theory is both superfluous and misleading. Dr. Strasser, an anatomist with an amateur's interest in physics, gives us a critical discussion of the theory, but it is manifest that he has not come near to understanding it. Prof. Rougier, a philosopher who has read all about the new physics, sets out to tell us something of the influence of the theory upon philosophy, but leaves us with the impression of a shallow and ill-digested understanding of the development of physical science and tells us little about philosophy. Prof. du Pasquier and Dr. L. Bloch are less ambitious in their aims; they are content to be expositors and not critics. The results are correspondingly more successful and will probably be very useful to the French reader.

But among the books before us, the English reader naturally turns to Prof. Eddington's Romanes Lecture to hear the latest thoughts of one who has done more than any man living to establish and to popularise the general theory of relativity.

The lecturer impresses it upon his audience that it is stale news that the events around us form a world of four dimensions. There is, however, something that is new. It used to be customary for us to think of this four-dimensional world as having a definite set of sections, any one of which represented the state of the universe at a particular moment of absolute time, the whole being thus stratified in recognisable layers. But now this stratification has disappeared, there are no absolute time sections; it is only the individual observer who, to meet his own convenience, dissects the whole into "rashers," labelling each with the mark of an instant of his own consciousness. With a wealth of illustration and with language both grave and gay Prof. Eddington seeks to cure us of our egoistic outlook, and to persuade us to the wider view which finds truth, not in a particular picture of reality seen from one angle, but in a vision which includes and comprehends every possible picture. "It is only in this undissected combination of four dimensions that the experiences of all observers meet." On this we need scarcely dwell here, save to remind ourselves that the fault from which he would save us is one to which men in all ages have been prone, and not the least sinners have been those whose profession was the pursuit of exact truth. Yet we cannot help feeling that at times the preacher goes too far and so damages his case. To quote an illustration from the lecture. We allow an apple to fall. The moment the apple is released the earth begins to rush up to meet it. This is "the apple's view of things." "It is simpler than Newton's. We should regard it as on an equal footing with that of a terrestrial observer." This is very like asking an engine-driver to admit that it is quite natural to consider that when he admits the steam to the cylinder he sets not the engine but the whole universe in motion.

This is trifling however. Let us return to our destratified world of four dimensions. If we have been able to achieve this vision or to conceive of its possibility, we have grasped the essence of the doctrine of relativity, and we have come near to a superhuman view of history. The world is laid out before us as a changeless whole. Time and space are no more.

All is static. Dynamics has been resolved away. We can no longer ask about causes; that is to go back to the human point of view. We can simply gaze upon the scene and seek to catch some of its salient features.

So far as our present conceptions go, one of the most striking things about the picture will be that it is fibrous. The tangible part of it will be a great number of threads, one-dimensionalities. These represent electrons. Mere mortals think of them as moving points, but with our new vision we see them as continuous threads. These are chiefly present in bundles, twisted together into ropes; what are these? They are the material bodies of the mortals. One is an atom. Another, much more complex, is a man; another is a chair. The former in one part is gathering more threads to itself; in another part the threads unravel and dissipate. Such is life. In one part the chair-rope and the man-rope are in contact; the man is sitting on the chair. But of the behaviour of man as mortal the picture tells us little. We must become mortal and see only sections of the picture before we can see him as a living being with an unfolding consciousness. If the poet and the mystic do indeed aspire to free themselves from the fetters of time and space, as we read in the concluding passage of the lecture, we fear that they will find but little left either of poetry or of mystery in the world after which they yearn.

But, leaving the poet aside, and returning to the physicist, what is left for him in the great synthesis of all science into the one map of all events? What becomes of his vocation of measurement? As Prof. Eddington emphasises again and again, he too, with all his experiments, is in the picture. His rules, scales, clocks, photographic plates are all there; their whole history is depicted. All his experiments of measurement are represented by the passage through the picture of the threads that represent the marks on the scales, meeting and intersecting the threads that represent other particles of matter. The four-dimensional picture itself is not to be measured. It contains within itself the process of measurement in the ordinary three-dimensional world and all the results are recorded for us to read. We have no four-dimensional scale which we may move about and apply to different parts of the picture for the sake of comparison. We merely stand, look, and try to read what we see.

Perhaps Prof. Eddington does not see the picture quite in this way. Perhaps the "world" for him is a four-dimensional continuum in which our threads are merely lines of singularity. He seems to contemplate as "measurable" the intervals between pairs of points in this continuum which do not correspond to events in the history of any particle or electron in the material universe. But we wish to ask him how these intervals are in practice to be measured. He says, "When we have mastered the geometry of the world we shall have inevitably learnt the mechanics of it." That is so. A complete description of the world lines of all particles necessarily tells us all about the phenomena of motion.

But to master the geometry of the world means to describe its main features by means of a few simple propositions. In Prof. Eddington's view, the process consists in measuring all the intervals between all pairs of neighbouring events, and then in examining whether these intervals will fit together in an Euclidean fashion, or in a particular type of non-Euclidean scheme. If we discover that they will fit in a recognised and manageable mathematical scheme, we have mastered the geometry of the world.

But we ask again how are these intervals to be measured. Since all measurements are contained in the picture, and since for the description of the picture event by event no system of intervals is necessary, the whole of our experimental measurements have nothing at all to do with a scheme of intervals, and any geometrical system whatever may be used for the purpose of attaching intervals. What, then, is it which discriminates between Einstein's system and any other possible one? It is simply this, that if we adopt that system, the facts of the motions of particles or of the propagation of light can be expressed in a very simple form. The path of Mercury, for instance, is a geodesic. Possibly this fact may be further analysed and shown to follow from the configuration of the electron being spherical. But in any case we cannot measure the tube which would represent such an electron in the super-world of four dimensions.

Thus Einstein's law of gravitation, by itself, is not a statement about the world at all. It is only when it is taken in conjunction with some other hypotheses, such as that the path of a particle is a geodesic, that it predicts anything, and becomes capable of experimental test. The world itself cannot be said to be either Euclidean or non-Euclidean, for it does not furnish us with definite values for the intervals between all pairs of events in the continuum. We may say that the world-phenomena are more simply described on the basis of a non-Euclidean system than on a Euclidean system; but it is surely not allowable to go further and say that this is "because the world is not a Euclidean or flat world." Prof. Eddington would perhaps reply that for him the world is nothing more than the measurements that we make of it, and that these measurements do not fit in a Euclidean scheme. But this brings us round again to the same question, what is meant by measurements of the four-dimensional whole? We would ask our lecturer to give us a sequel to this discourse in which, assuming the four-dimensional presentation, he would state explicitly, either in general terms or by precise illustration, how he would compare the intervals between any two pairs of events.

E. CUNNINGHAM.

The Marketing of Whole Milk.

The Marketing of Whole Milk. By Dr. H. E. Erdman. (The Citizen's Library: Marketing Series.) Pp. xvi+333. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1921.) 21*s.* net.

THE recent disputes concerning the price of milk have again shown how difficult the problem has become under modern conditions, more especially in the large towns. The farmer is no longer able to take his milk direct to the consumer except in the case of a village or small town, and there has arisen a class of dealers or distributors who occupy the place of the middleman. Some of these distributors are large companies with the command of much capital, and their powerful organisations have led to something very like monopoly. The producers, on the other hand, have also organised themselves, and a struggle between the two parties has recently ended. In the volume under notice, this question as it appears in the United States is very completely analysed, and Prof. Erdman, who is an economist, has dealt with it more fully and critically than has previously been attempted. After discussing the peculiar position occupied by milk as a foodstuff, and the regulations which the public health authorities of all civilised countries have imposed, the author takes marketing and distribution, instances what has been done in the past and states the present position. The part played by the middleman and dealer is made clear, and the rise of collective bargaining is illustrated by the action of the Orange County farmers in their successful fight with the New York dealers in 1883, which may be regarded as the beginning of what has now become the general practice in the large American cities. The strike—or better the boycott—has been the weapon of the producers, and experience has shown that it is two-edged, owing to the difficulty which the farmer has in disposing of his milk—a perishable commodity—except by making it into cheese or butter or, at worst, by feeding it to stock, all of which courses are seldom remunerative. It is made clear that the producers must also submit to regulations governing their combined action, otherwise the results are doomed to failure.

Other matters dealt with are the difficulty of arriving at the cost of milk, owing to the position of the farm, the ability of the farmer, the proximity to market, and so on, and it is laid down that the method of arriving a a basic price can only be a starting-point in negotiations

This book, which makes a strong appeal to the genera reader, will be of interest to all concerned in the mill trade, whether as producers, distributors, or consumers and it should lead to what the author regards as th only solution of the difficulty—"a better understandin all round."

Our Bookshelf.

Proceedings of the London Mathematical Society. Second Series. Vol. 20. Pp. liv+502. (London: F. Hodgson, 1922.) n.p.

THE present volume of the London Mathematical Society's Proceedings is the fifty-fifth issued since the foundation of the society and the twentieth in the present (large octavo) series. Like the preceding volumes issued by the society, it consists mainly of papers which embody original investigations on various mathematical subjects. Many of the papers, of which there are nearly forty, will appeal only to a limited class of reader. In mathematics, even more than in other sciences, the results of new investigations are apt to appear abstruse to the lay mind. The solution of a cubic equation, the Newtonian theory of gravitation, even the elementary applications of the calculus, fundamental and well known as they are now, were not familiar to the world, or even to the general run of university students, for many years after their discovery. By providing facilities for the publication of these specialised researches the London Mathematical Society has earned the deep obligation of the English mathematical world. Practically all the society's income is expended in producing its Proceedings, and, in view of the increased cost of printing, a large membership is essential to provide adequate funds. Inasmuch as every man is a debtor to his profession, every English mathematician should help to further the work of the society by becoming a member.

In the volume under review the articles most likely to appeal to the general reader are the excellent obituary notices of the late Lord Rayleigh and Herr Adolf Hurwitz, written by Profs. Lamb and Young respectively. There is also printed a presidential address on "Some Problems in Wireless Telegraphy" by Prof. Macdonald. Of the more technical papers it would be invidious to single out any one for special mention. The society insists on a high standard of excellence in everything it prints, and the inclusion of a paper in the Proceedings is a sufficient guarantee of quality. We notice that there is an almost entire absence of pure geometry from the present volume. Can it be that research in this subject is no longer encouraged in England?

The method of indexing each individual volume of the Proceedings leaves nothing to be desired. A subject index to the first thirty volumes of the first series was issued many years ago. We suggest that the time is approaching when the Council should consider the desirability of publishing a further subject index to the later volumes.

W. E. H. B.